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(54) Neat cutting oil composition

(57) The present invention relates to a neat cutting oil composition comprising, based on the total weight of the composition, from 1 to 99.5% of a hydrogenated dimer or a mixture of hydrogenated dimers, said dimer(s) being selected from the group consisting of octene dimers, decene dimers and dodecene dimers.

The invention also relates to a process for machining metals and to the use of the neat cutting in metal machining operations.

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Description

[0001] The present invention relates to a neat cutting oil composition and to a process for working metals and metal alloys.

[0002] Cutting fluids have been used for a long time to perform generally the following functions :

- lubricate the chip/tool and tool/workpiece contacts, reduce friction (decrease cutting forces and torques);
  extend tool life;
  improve surface finish;
- cool the workpiece and the tool, in order to :

  dissipate heat in the cutting zone;
  protect the metal tool and workpiece;
  improve dimensional accuracy; and

- protect the workpiece, tool and machine,

  flush and remove metal chips;
  prevent chip/tool welding; and
  control the Built Up Edge (BUE).

[0003] There are two main types of cutting fluids : neat cutting fluids and water-miscible cutting fluids.

[0004] Neat cutting fluids are usually preferred when excellent lubrication, good rust protection and surface finish are required.

[0005] However, they tend to evaporate and generate mists.

[0006] There is a therefore a need to reduce evaporation and mist generation of neat cutting fluids, in order to improve working conditions and provide a safer working environment. However, reducing evaporation usually means increasing viscosity, which reduces the cooling efficiency.

[0007] There is no teaching or suggestion in the prior art as to how a neat cutting fluid satisfying the above need can be produced without impairing its cooling efficiency.

[0008] The invention thus provides a neat cutting oil composition which, besides exhibiting low misting and evaporation tendencies, also has excellent cooling properties.

[0009] Specifically, the invention provides a neat cutting oil composition comprising, based on the total weight of the composition, from 10 to 99%, preferably from 70 to 99%, of a hydrogenated dimer or a mixture of hydrogenated dimers, the dimer(s) being selected from the group consisting of octene dimers, decene dimers and dodecene dimers.

[0010] The invention further provides a process for preparing the neat cutting oil composition.

[0011] The invention also provides a process for machining metals, comprising applying an effective amount of the neat cutting oil composition of the invention to the metal being machined.

[0012] Finally, the invention provides the use of the neat cutting oil composition of the invention in a metal machining operation.

[0013] The invention is now disclosed in more details in the following specification and in reference to the drawings in which :

Figure 1 is a graph showing the number of broken tools in metal working operations, when using the cutting oil compositions of the invention and of the prior art;
Figure 2 is a graph showing the diameter variations and roughness observed on a metal piece after turning operations with the cutting oil compositions of the invention and of the prior art;
Figure 3 is a representation of the device used to generate mist from a cutting oil composition and measuring it;
Figure 4 is a graph showing the particle size of the mist generated from the cutting oil compositions of the invention and the prior art; and
Figure 5 is a graph showing the specific heat capacities as a function of the temperature with the cutting oil compositions of the invention and of the prior art.

[0014] The present inventor has found that hydrogenated octene, decene or dodecene dimers have a low viscosity whilst surprisingly also having low tendencies to evaporate and generate mist.

[0015] By "a hydrogenated dimer or a mixture of hydrogenated decene" is herein intended, a hydrogenated dimer or a mixture of hydrogenated dimers, respectively, which is/are substantially pure, i.e. at least 90% pure ,preferably at least 95% pure, and more preferably at least 98% pure.

[0016] Such hydrogenated dimers typically have a viscosity from 5 to 7 cSt at 40°C, preferably from 5 to 6 cSt at 40°C.

[0017] The preferred dimers are decene dimers.

[0018] There are 5 different isomers of decene.

[0019] The dimerization/hydrogenation of each decene gives a mixture of several decene dimer isomers, which result from rearrangements of one or two methyl groups in the dimer molecule.

[0020] The preferred decene dimers are hydrogenated 1-decene dimers.

[0021] These hydrogenated 1-decene dimers can be prepared using sulphated zircona catalyst as described in Sarin, R., Tuli, D.K., Sinharay, S., Rai, M.M., Ghosh, S., and Bhatnagar, A.K., ACS, *Div. Petr. Chem. Reprints,* **41** (1996) 625.

[0022] The neat cutting oil composition of the invention may comprise conventional additives, such as lubricity agents, antioxidants, extreme-pressure and anti-wear agents, anti-mist agents.

[0023] Examples of lubricity agents are long chain polar molecules, like fats, fatty acids, vegetable oils and esters.

[0024] Examples of extreme-pressure and anti-wear agents are natural fatty oils, synthetic esters, fatty acids, fatty acid derivatives, elemental sulphur, inorganic sulphur compounds, phosphorus organic compounds, or chlorine organic compounds.

[0025] Examples of phosphorus organic compounds include dilauryl phosphate, didodecyl phosphite, trialkylphosphate such as tri(2-ethylhexyl)phosphate, tricresylphosphate (TCP), zinc dialkyl(or diaryl)dithiophosphates (ZDDP), phospho-sulphurized fatty oils, tricresylphosphate (TCP), trixylylphosphate (TXP), dilauryl phosphate, amine phosphates, phosphoric acid esters.

[0026] Examples of sulphur phosphorus organic compounds include sulphurised esters, fatty acids olefins, and fats, as well as mercaptobenzothiazole, sulphurized fatty oils, sulphurized terpenes, sulphurized oleic acid, alkyl and aryl polysulphides, sulphurized sperm oil, sulphurized mineral oil, and sulphur chloride treated fatty oils.

[0027] Examples of chlorine organic compounds include chlornaphta xanthate, cetyl chloride, chlorinated paraffinic oils, chlorinated paraffin wax sulphides, chlorinated paraffin wax, and zinc dialkyl(or diaryl)dithiophosphates (ZDDP).

[0028] Examples of anti-oxidants are metals deactivators like triazole derivatives, chain breakers like phenols, cresols derivatives, peroxyde decomposers like zinc dithiophosphates, metal dithio carbamates.

[0029] Example of anti-mist agents are high molecular weight polyisobutylenes.

[0030] Further elements on base oils and additives can be found in "Chemistry And Technology Of Lubricants", R. M. Mortier and S.T. Orszulik, VCH Publishers, Inc, First published in 1992.

[0031] The neat cutting oil composition of the invention is prepared by blending the base oil and the other ingredients, preferably under stirring or with any other mixing device and whilst controlling the temperature so that is does not exceed 70°C, and more preferably, 50°C.

[0032] The neat cutting oil composition of the invention can be used in various machining operations like internal, surface or external broaching, tapping, threading, honing, gear cutting, gear shaving, gear hobbing, gear generating, reaming, automatic works, milling, form turning, planing, parting off, drilling, boring, sawing or superfinishing.

[0033] The neat cutting oil of the invention is particularly adapted in machining operations like honing, deep hole drilling or screw cutting.

[0034] The neat cutting oil composition of the invention can be used in a metal machining operation in which a neat cutting oil is generally used, but it can also be used in a metal machining operation in which a water-based fluid is generally used as a cutting fluid.

[0035] A great number of metals can be machined with the oil composition of the invention. Examples include titanium alloys, nickel alloys like Nimonics ™, stainless steel like inconel, tool steel, high alloy steel, high carbon steel, mild steel, wrought iron, silicon aluminium alloys, cast iron, copper, copper alloys, bronze, brass, aluminium and aluminium alloys.

[0036] The following examples illustrate the invention without limiting it. All parts and ratios are given by weight, unless otherwise noted.

EXAMPLES

Preparation of the cutting oil composition

[0037] A composition is prepared by mixing the ingredients of Table 1 in the order in which they appear in this table. The temperature is maintained at a maximum of 50°C to ensure a complete dissolution and homogeneisation of the ingredients without impairing the properties of the oil.

TABLE 1

Ingredients	Content (wt%)
Commercial polyalphaolefin of grade 2 (PAO-2)*	83.8
Di-tertiobutyl paracresol (anti-oxidant)	0.2
Trioctylphosphate ester (extreme-pressure agent)	1
Di(2-ethylhexyl) adipate ester (lubricity agent)	10
Di-t-nonyl-polysulfide (antiwear agent)	3
Di-t-dodecyl-trisulfide (antiwear agent)	2

* PAO-2 predominantly comprises 1-decene dimers prepares through BF_3 catalysed oligomerisation of 1-decene

[0038] The characteristics of the composition of Table 1 are set out in Table 2.

TABLE 2

Property	Unit	Method	Typical characteristics
Colour (ASTM)		ISO 2049	LT 2.5
Viscosity at 40°C	CSt	ASTM D 445	6.75
Flash point	°C	ISO 2592	158
Pour point	°C	ISO 3016	LT-60

EXPERIMENTAL TESTING

[0039] A prior art cutting oil having the composition set out in Table 3 is prepared :

TABLE 3

Ingredients	Content (wt%)
Base oil (paraffinic, 9 cSt at 40°C)	56.8
Base oil (paraffinic, 100 SUS)	41
Sulfurized choice white grease (*)	2
Di-tertiobutyl paracresol	0.2

(*) : reaction product of a fat with sulfur, sold by Mayco Corporation

[0040] The characteristics of the composition of Table 3 are set out in Table 4.

TABLE 4

Property	Unit	Method	Typical characteristics
Colour (ASTM)		ISO 2049	5.0
Viscosity at 40°C	CSt	ASTM D 445	16.0
Flash point	°C	ISO 2592	184
Pour point	°C	ISO 3016	-18

a) Metal machining performances

[0041] The cutting oil composition of the invention (Table 1) and the cutting oil composition of the prior art (Table 3) were tested in machining operations, including turning, drilling, tapping, threading, grooving and parting off.

[0042] The test procedure is described in "New Neat Cutting Oil Technology for a Better Working Environment", Prince F. and Laily R., Proc. 6th Int'LFE Congress, Brussels, June 2-4, 1999, pp 1-11.

[0043] The machining performances of an oil composition are reflected by the number of broken tools. The lower

the number of broken tools, the higher the performance.

[0044] The results are shown in Figure 1. As fewer tools are broken when the oil of the invention is used, the machining performances of the oil of the invention are better than those of the oil of the prior art.

[0045] The diameter variation and the roughness of a metal piece which was submitted to turning operations were also measured. The results are shown in Figure 2. As can be seen, the values are lower with the oil composition of the invention, which is therefore better than the oil composition of the prior art.

b) Mist formation

[0046] The Renault mist test D65 1649 is carried out with the cutting oil composition of the invention and with the cutting oil composition of the prior art, using a device as represented in Figure 3.

[0047] An air flow is filtered and then flows trough a venturi, sucks the oil up to generate a spray. The spray then reaches a glass cylinder where the oil is partially recondensated. The mist formed is evaluated by weight measurement.

[0048] The results are shown in Figure 4. The cutting oil composition of the invention generates much less mist than does the cutting oil composition of the prior art.

c) Particles diameter

[0049] The diameters of the particles of the mist generated by the device of Figure 3 from the oil composition of the invention and the oil composition of the prior art (Table 3) are determined using a particle size analyser known under the tradename SPRAYTEC and sold by the company MALVERN.

[0050] This analyser determines a particle size pattern of oils, using a laser diffraction technique. The particle size is inversely proportional to the angle of diffraction of the incident light. Such a device comprises :

- a He-Ne laser (λ = 0.633 μm);
- a photosensitive silicon detector; and
- data collection and analysis means.

[0051] The results are shown on Figures 4.

[0052] The average particle diameter are found to be 4 μm for the neat cutting oil composition of Table 1 and 3 μm for the neat cutting oil composition of Table 3.

[0053] The larger the particles, the lower the tendency to generate mist reaching the operator's lungs alveoli. The neat cutting oil composition of the invention provides a safer working environment that the neat cutting oil composition of Table 3.

d) Cooling effect

[0054] Figure 5 is a graph showing the specific heat capacities as a function of the temperature with the cutting oil compositions of the invention and of the prior art, according to the ASTM D4419 test method for differential scanning calorimetry.

[0055] As can be seen, the neat cutting oil of the invention provides a better heat removal than the neat cutting oil composition of Table 3.

Claims

1. Neat cutting oil composition comprising, based on the total weight of the composition, from 1 to 99.5% of a hydrogenated dimer or a mixture of hydrogenated dimers, said dimer(s) being selected from the group consisting of octene dimers, decene dimers and dodecene dimers.

2. Neat cutting oil composition according to claim 1, comprising, based on the total weight of the composition, from 70 to 99% of said hydrogenated decene dimer or mixture of hydrogenated dimers.

3. Neat cutting oil composition according to claim 1 or 2, comprising a hydrogenated decene dimer or a mixture of hydrogenated decene dimers.

4. Neat cutting oil composition according to any one of claims 1 to 3, comprising hydrogenated 1-decene dimers.

5. Neat cutting oil composition according to any one of claims 1 to 4, in which said decene dimer or mixture of decene dimers has a viscosity comprised between 5 and 7 cSt at 40°C, preferably between 5 and 6 cSt at 40°C.

6. Neat cutting oil composition according to any one of claims 1 to 5, further comprising at least one ingredient selected from the group consisting of lubricity agents, antioxidants, extreme-pressure and anti-wear agents and anti-mist agents.

7. Process for the preparation of a neat cutting oil composition according to claim 6, comprising blending the decene dimer or mixture of decene dimers and the other ingredients under stirring or with any mixing device.

8. Process according to claim 7, wherein the blending is carried out at a temperature which does not exceed 70°C, preferably 50°C.

9. Process for machining metals, comprising applying an effective amount of the neat cutting oil composition according to any one of claims 1 or 6 to the metal.

10. Use of the neat cutting oil composition according to any one of claims 1 to 6 in a metal machining operation in which a neat cutting oil is generally used.

11. Use of the neat cutting oil composition according to any one of claims 1 to 6 in a metal machining operation in which a water-based fluid is generally used as a cutting fluid.

12. Use according to claim 10 or claim 11, wherein the machining operation is honing, deep hole drilling or screw cutting.

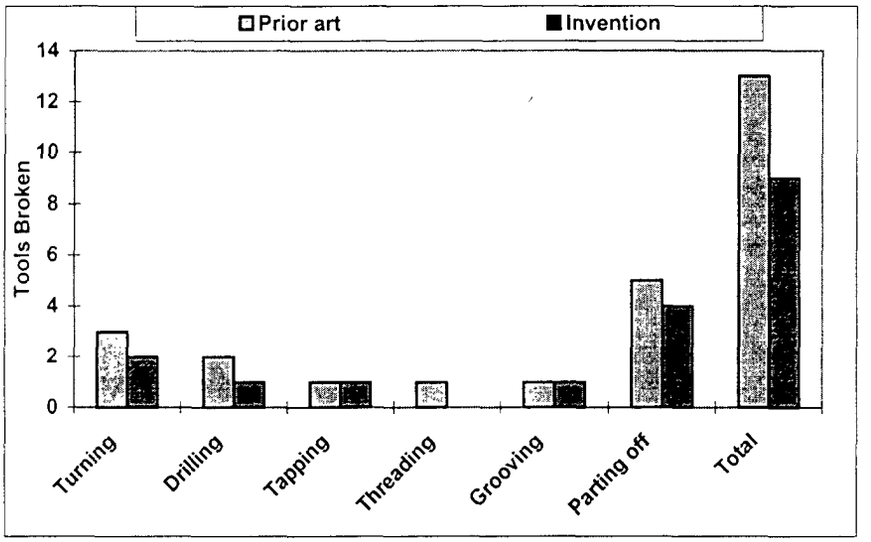
Prior art
Invention
Tools Broken
14
12
10
8
6
4
2
0
Turning
Drilling
Tapping
Threading
Grooving
Parting off
Total

Fig. 1

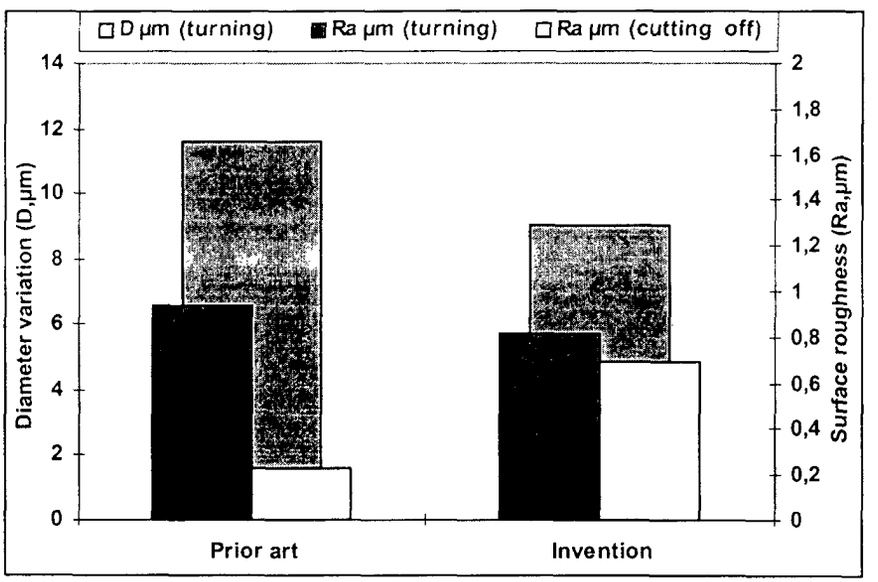
D µm (turning)
Ra µm (turning)
Ra µm (cutting off)
Diameter variation (D,µm)
Surface roughness (Ra,µm)
14
12
10
8
6
4
2
0
2
1,8
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
Prior art
Invention

Fig. 2

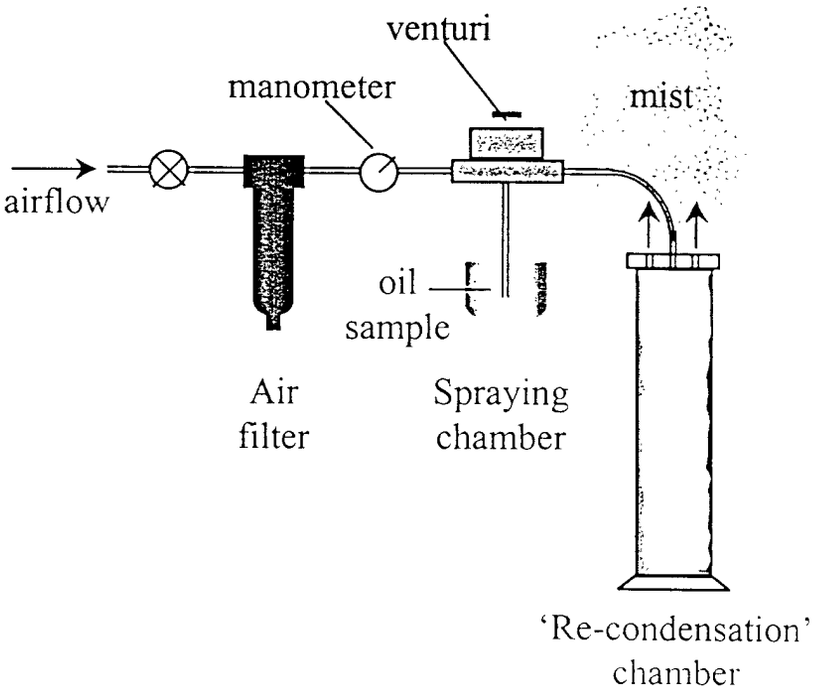
venturi
manometer
mist
airflow
oil
sample
Air
filter
Spraying
chamber
'Re-condensation'
chamber

Fig. 3

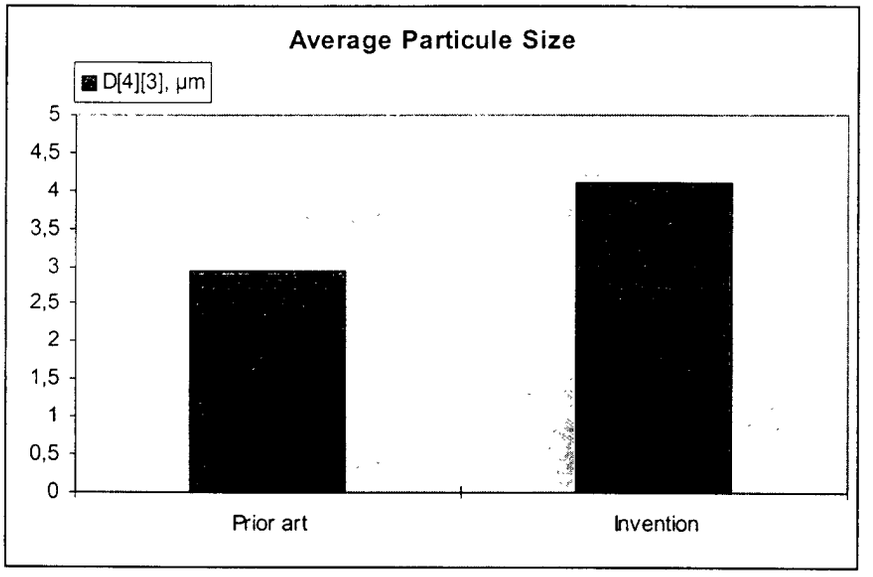
Average Particule Size
D[4][3], µm
5
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
Prior art
Invention

Fig. 4

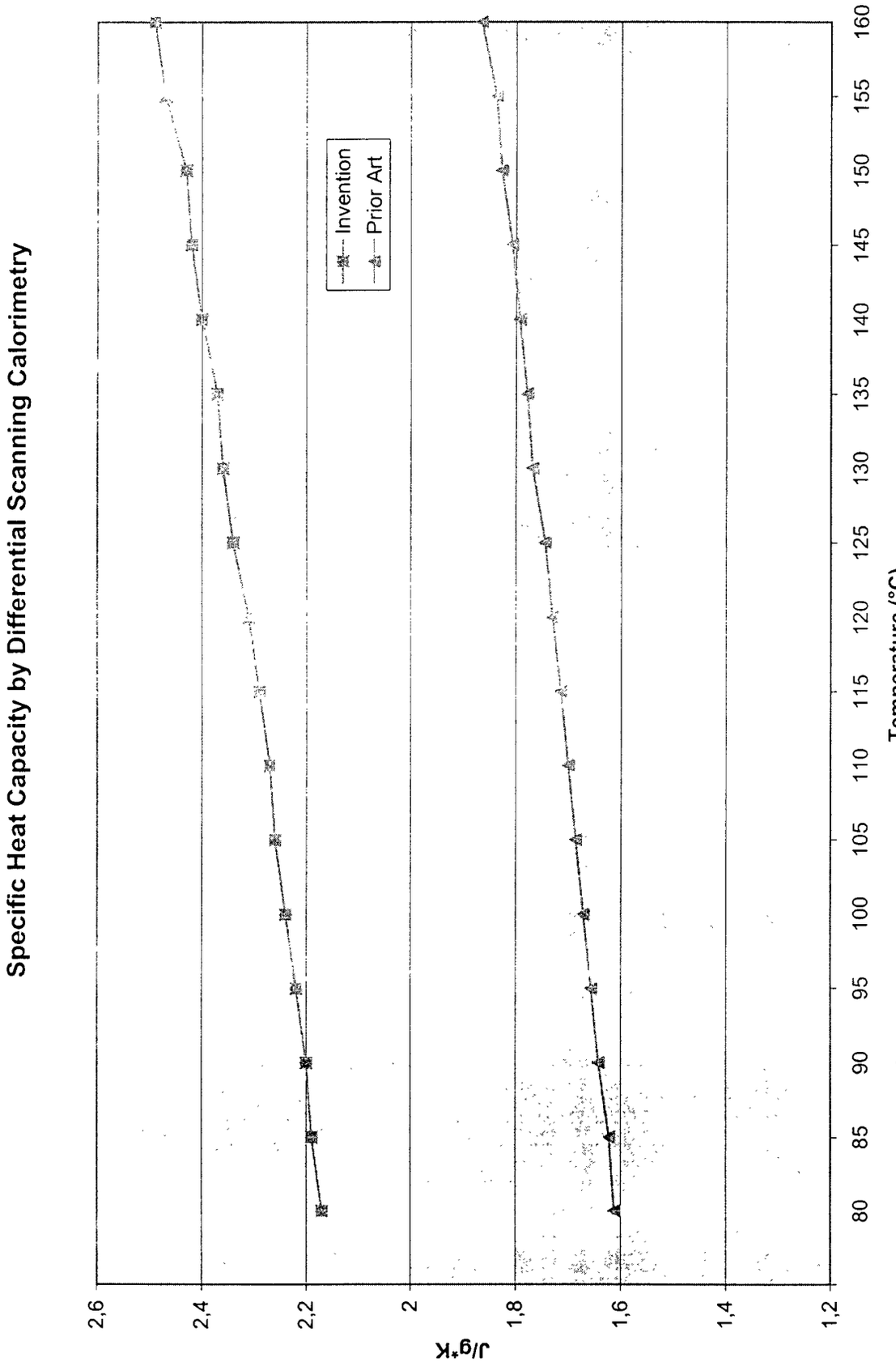
Specific Heat Capacity by Differential Scanning Calorimetry
Invention
Prior Art
J/g*K
2,6
2,4
2,2
2
1,8
1,6
1,4
1,2
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160
Temperature (°C)

Fig. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 40 0352

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X A	EP 0 467 345 A (ETHYL CORP) 22 January 1992 (1992-01-22) * abstract * * examples 1-8 * * table 2 * * example 11 * * page 7, line 47 - page 7, line 53 * * claims 1-3,5,8 * ---	1-8 9-12	C10M107/10 C10M111/04 //C10N40:22
X A	US 5 210 346 A (DILEO THOMAS J) 11 May 1993 (1993-05-11) * column 1, line 5 - column 1, line 9 * * column 2, line 6 - column 2, line 12 * * column 2, line 39 - column 2, line 54 * * examples 1,3 * ---	1-8 9-12	
X A	US 5 817 899 A (CUPPLES BARRETT L ET AL) 6 October 1998 (1998-10-06) * abstract * * column 1, line 21 - column 1, line 23 * * column 7, line 17 - column 7, line 21 * * column 7, line 62 - column 7, line 65 * * column 8, line 9 - column 8, line 12 * -----	1-4 5-12	TECHNICAL FIELDS SEARCHED (Int.Cl.7) C10M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	5 July 2000	Perakis, N

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 40 0352

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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05-07-2000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0467345 A	22-01-1992	US 5068487 A	26-11-1991
		US 5171918 A	15-12-1992
		CA 2046937 A	20-01-1992
		DE 69126173 D	26-06-1997
		DE 69126173 T	28-08-1997
		JP 4226511 A	17-08-1992
		US 5171905 A	15-12-1992
		US 5250750 A	05-10-1993
US 5210346 A	11-05-1993	CA 2128098 A,C	19-08-1993
		DE 69318010 D	20-05-1998
		DE 69318010 T	06-08-1998
		EP 0625180 A	23-11-1994
		HK 1006211 A	12-02-1999
		JP 7507077 T	03-08-1995
		WO 9316152 A	19-08-1993
US 5817899 A	06-10-1998	US 5550307 A	27-08-1996
		US 5420373 A	30-05-1995
		EP 0741120 A	06-11-1996
		DE 69501067 D	02-01-1998
		DE 69501067 T	07-05-1998
		EP 0699647 A	06-03-1996
		DE 69506935 D	11-02-1999
		DE 69506935 T	27-05-1999
		EP 0678493 A	25-10-1995
		FI 951380 A	25-09-1995
		JP 7310078 A	28-11-1995

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82